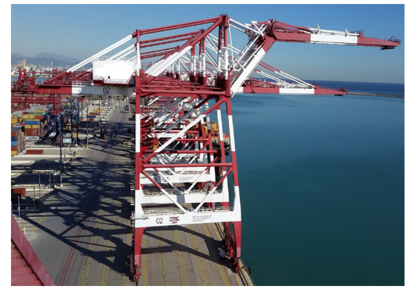
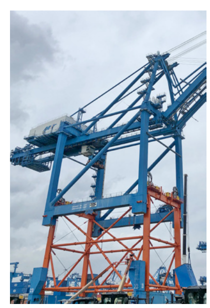
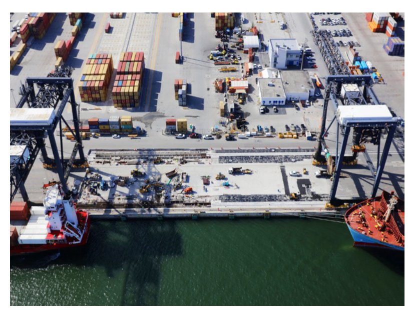
CRANE STRUCTURAL MAINTENANCE SERVICES

Liftech Consultants Inc.







Liftech

LIFTECH CONSULTANTS INC.

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CRANE MAINTENANCE SERVICES

ABOUT US

Liftech Consultants Inc. has provided structural engineering services since 1964. We are at the forefront of marine terminal technology and strive to develop new technology that improves terminal productivity and safety. We are recognized worldwide as experts in the design of container handling cranes and other equipment. Our experience also includes the structural design of wharves, buildings, heavy lift structures, and other special structures. Our international clients include owners, engineers, operators, manufacturers, contractors, consultants, riggers, and architects.

THE IMPORTANCE OF CRANE MAINTENANCE

Cranes need a structural checkup occasionally, just like your body needs a physical. Structural examinations can detect trouble before failures occur. It is important to spend your money wisely, so the exam should be directed to those structural components most likely to fail and that will result in the most serious consequences.

All cranes are not equal. Some have better design and workmanship. Some have heavier use. All have cracks at welds. Imperfections are unavoidable. Some cracks are large and grow fast; some are small and grow slowly. Some are a serious threat and are important. Some are only a nuisance. The examination should find the important cracks and be tailored to each crane's needs.

How much will the examination cost and how much is it worth? How much risk is acceptable? Can you accept minor nuisance failures? What chance of serious failure is acceptable? What is your budget? Answering these questions is difficult. Deciding what, when, and how to examine your crane is even more difficult.

Liftech can help you decide.

In our fifty years of practice, Liftech has provided structural maintenance advice to crane operators, owners, and manufacturers. We have investigated a number of failures and developed designs for repairs and improvements. We have been developing structural maintenance plans since 1975 when a low profile crane hanger failure caused a catastrophe. The plans and methods we developed to avoid future failures have a proven track record.

ATTACHMENTS

The following documents are related to Liftech's Crane Maintenance Services. For more information about us, please visit our website: www.Liftech.net

- Rational Approach
- Sample Projects
- Selected Crane Maintenance Projects
- Company Overview
- Company Principals

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CRANE STRUCTURAL HEALTH, A RATIONAL APPROACH

Cranes need a structural checkup occasionally, just like your body needs a physical. Structural examinations can detect trouble before failures occur. It's important to spend your money wisely, so the exam should be directed to those structural components most likely to fail and that will result in the most serious consequences.

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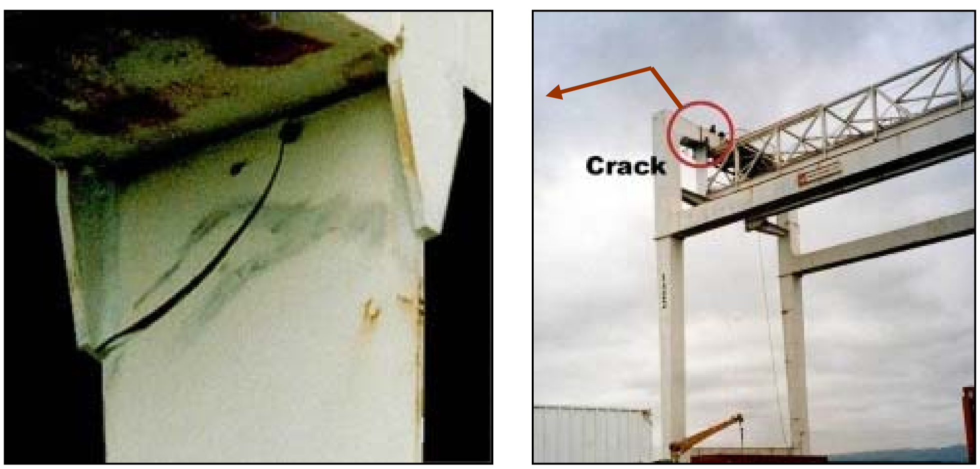
Liftech can help you decide.

LIFTECH EXPERIENCE

In our nearly fifty years of practice, Liftech has provided structural maintenance advice to crane operators, owners, and manufacturers. We have investigated several failures and developed designs for repairs and improvements. We have been developing structural maintenance plans since 1975 when a low profile crane hanger failure caused a catastrophe. The plans and methods we developed to avoid future failures have a proven track record.



Fatigue Failure on Low Profile Crane Boom Hanger

YOUR CRANE HAS BEEN OVERLOAD TESTED, SO WHY WORRY?

Periodic overload tests only verify that your crane can support the load in the condition existing when the test was performed. Conditions change. Initial cracks grow with use. The heavier the loading and the more numerous the load cycles, the faster the cracks grow. A test load is not sufficient to provide the reliability you expect. If a crack grows to a critical size in an undesirable location, sudden disastrous failure may occur. Periodic examinations are required to maintain acceptable reliability, and are requirements widely included in crane standards and specifications. The British Standard BS 7608:1993 explains why these examinations are needed. The new European Normal, BS EN 1993-1-9:2005, requires periodic examinations. Periodic inspection requirements have been in the Liftech specification since 1980, years before inclusion in the BS standards.

Fatigue failures tend to occur, either early in a crane's life, after a few hundred thousand load cycles, or later in its life, after several million or more load cycles. Early failures are called infant failures and later failures are called aging failures. Infant failures are due to design or fabrication errors, overloads during transport and erection, or abuse. Aging failures are due to small, usually initially acceptable cracks, growing slowly during repeated stress cycles. Early and later periodic inspections and repair reduce the chance of either occurring.

HOW TO PROCEED?

Inspect, but use inspection money wisely. Focus inspection on important details. Use a structural maintenance plan based on engineering analysis, fracture mechanics, experience, and the risk you find acceptable.

HOW MUCH INSPECTION IS TOO MUCH?

What risk is acceptable? Of course, the operator would like no risk. This is the usual answer the first time an operator is asked "How much risk is acceptable?" Unfortunately, this is impossible. There is always some risk. Reliability is always less than one hundred percent. We can calculate reliability.

How much risk can you accept? The Liftech criteria for periodic inspection of new cranes are based on a one in a thousand chance of failure in members that can fail without serious consequence, non-fracture critical members (NFCMs), and a one in one hundred thousand chance of failure in members that would cause collapse, fracture critical members (FCMs).

Factors affecting inspection costs include the number of cranes, extent of inspection, access for inspection and the need for equipment, corrosion, inspection methods, the need to remove paint, and others.

If your budget is limited, you may decide to only examine FCMs and to tolerate nuisance NFCM failures. If your budget is larger, you may decide to examine some or all of the NFCMs. Only performing non-destructive testing on FCMs and visually inspecting NFCMs will reduce inspection efforts by 50% or more. Some of the reduced inspection effort will be offset by the increased repair effort. Other inspection variations can be considered.

The appropriate examination method depends on weld types and connection geometries. The recommended frequency of inspections depends on several factors:

> What are the design and fabrication specifications? Is fracture toughness specified? What is the manufacturer's track record? Was the design peer-reviewed by an independent consultant? Was the review cursory or detailed? Was the fabrication monitored by an independent agency? Was

nondestructive testing (NDT) such as magnetic particle inspection (MT) and ultrasonic testing (UT) performed by an American Society for Nondestructive Testing (ASNT) Level II or III inspector? Are material tests available and what testing was performed? Has the crane been inspected since it was commissioned? What is the load history? Have there been cracking problems? Do you operate several similar cranes and how have they performed?

Once these questions are answered and other data are available, we can calculate the structural reliability of the crane based on structural analysis and fracture mechanics. If the data are not available, we can provide suggestions to improve reliability based on our experience with similar cranes.

DEVELOP THE STRUCTURAL MAINTENANCE PLAN

Once the above questions are answered and information is gathered, Liftech can make a preliminary review of your needs and discuss alternatives with you.

Once goals are identified and your needs are understood, we can prepare a plan. The plan will include recommended examinations, inspection intervals, and possibly some recommendations for immediate improvement. New examination methods are available which may reduce costs, such as Alternating Current Field Measurement (ACFM) and Phased Array UT (PAUT). We will rely on your data, our calculations, and our experience. The plan will consider the fundamental question: What is the cost and what is it worth?

FOLLOW THE PLAN

Liftech does not provide inspection services. These are best performed by a local agency specializing in NDT inspections of dynamically loaded steel structures. Liftech should oversee the inspection operations and results. Just as with a medical exam, the doctor prescribes the tests, the technician performs the tests, and the doctor advises the patient based on the test results.

The inspection results should be properly reported and well documented for future reference. Once an initial inspection is performed, and after each structural inspection, the recommendations for future periodic inspection should be tuned according to the findings. For example, if the structure has had fewer fatigue cracks than expected, the duration until the next inspection can be increased.

WHEN CRACKS ARE FOUND, WHAT SHOULD YOU DO?

Repair fatigue cracks with proper repair procedures to restore the material to an undamaged condition.

Problematic weld details can be improved by toe-grinding, peening, or improving the design. On some projects, we have recommended improvements that reduce the stress range and notch effect to significantly increase reliability and extend the crane’s useful life. When it is impractical to perform detailed analyses, we can suggest improvements based on our experience with thousands of cranes.

SUMMARY

With an appropriate structural maintenance plan, you will use your maintenance budget wisely and operate your cranes reliably. Your cranes will be healthy and last for many years.

LIFTECH CONTACTS

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SOME REFERENCE MATERIAL

Excerpt from Liftech Container Crane Specification:

Structural Maintenance Program

The fatigue criteria in this specification are based on producing a damage-tolerant design. Because of the variation of fatigue performance and the usage may exceed the design conditions, there is a risk that a structure or component may fail in service. When fatigue cracks develop, the remaining structure should sustain the maximum working load until the cracks are discovered. Satisfactory performance of the damage tolerant design, therefore, depends on adequate methods of fatigue crack detection and the ability to repair or replace the damaged component. The intent of this section is to define a method of routinely inspecting for fatigue cracks to significantly improve structural reliability.

Periodic structural inspections are required to detect cracks that have developed during the life of the crane. The inspection intervals defined below are based on fracture mechanics calculations, reliability analysis, and the fact that fatigue cracks can be classified as infant and aging failures. The Delivery Inspection and Warranty Inspection should detect infant failures and subsequent periodic Maintenance Inspections should detect aging failures. Infant failures are primarily due to deficient fabrication; underestimation of fatigue damage, which may be due to deficient design or excessive loading; or a combination of these. Aging failures are primarily due to cumulative damage from normal operations and properly designed and manufactured components.

Technical References

Fatigue design and structural maintenance provisions in the Liftech specification are available on request.

Books about Fatigue of Welded Structures

T. R. Gurney, *Fatigue of Welded Structures,* 2nd Edition. Cambridge, England: Cambridge University Press, 1979.

S. J. Maddox, *Fatigue Strength of Welded Structures*, 2nd Edition. Cambridge, England: Abington Publishing, 1991.

Relevant Codes and Standards about Fatigue of Welded Structures

British Standards Institution, BS EN 1993: Part 1-9:2005, *Eurocode 3: Design of steel structures—Part 1-9: Fatigue*. London: BSI, 2005.

British Standards Institution, NA to BS EN 1993: Part 1-9:2005, *UK National Annex to Eurocode 3: Design of steel structures—Part 1-9: Fatigue*. London: BSI, 2008.

British Standards Institution, PD 6695-1-9:2008, *Recommendations for the design of structures to BS EN 1993-1-9*. London: BSI, 2008.

British Standards Institution, BS 7608:2014, *Guide to Fatigue Design and Assessment of Steel Products*. London: BSI, 2014.

British Standards Institution, BS EN 13001: All Parts:2004, *Crane safety—General design—General principles and requirements.* London: BSI, 2005.

American Welding Society, AWS D1.1/D1.1M:2010, *Structural Welding Code – Steel*, 22st Edition. Miami, FL: American Welding Society, 2010.

American Welding Society, AASHTO/AWS D1.5M/D1.5:2008, *Bridge Welding Code,* 5th Edition. Washington, DC: American Association of State Highway and Transportation Officials, Miami, FL: American Welding Society, 2008.

OTHER STRUCTURAL ISSUES NOT ADDRESSED IN THIS WHITE PAPER

Corrosion

Corrosion needs attention. Usually, corrosion inspection can be included along with the NDT inspection for fatigue cracks. This will be the subject of another white paper.

Corrosion Damage

Limit State Strength

A review of structural strength may be worthwhile. The test load verifies that normal operating loads can be supported. The test does not verify an adequate margin of safety, especially for overloads due to wind, earthquake, and emergency stops. One of the more common, though infrequent, causes of collapse is due to storm wind or microbursts. The wharf hardware is usually designed by the wharf designer who may not use the same criteria as the crane designer. Many major losses are due to tie-down anchorage failure. This will be the subject of another white paper.

Typhoon Damage

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SELECTED CRANE ASSESSMENT PROJECTS

				Services Provided									
				Health Assessment				Damage Assessment					
Client & Location	**Year**	**Crane Supplier & Crane Type (Twin-Lift STS typical)**	Number of Cranes	Condition Survey	Inspection Program	Life Assessment	Repair Program	Earthquake	Voyage Collision	Hurricane	Vibration	Fatigue or Operations	Corrosion
Maher Terminals New Jersey	2020	Fantuzzi A-frame	5		✓								
DP World Canada, Saint John, NB, Canada	2018	Paceco A-frame	2		✓								
TOTE Maritime Jacksonville, Florida	2018	Kocks & CMI A-frame	4	✓									
McKay Int'l. Engineers Benicia, California	2017	Bulk Loaders	2	✓		✓							
Douala International Terminal, Cameroon	2015	IHI A-frame	2	✓		✓							
CH2M New York and Baltimore	2015	Asset maintenance and renewal		✓		✓							
Red Team Northport, Malaysia	2015	IMPSA A-frame	5	✓	✓		✓						
Virtual Investment Group Singapore	2012	Krupp Coal Loader	1	✓	✓								
Matson Navigation Hawaii	2012	Barge Crane	1						✓				
Matson Navigation Hawaii	2010 to 2012	Barge Cranes & Runway Girders	2	✓	✓		✓						
Rio Tinto Alcan Quebec, Canada	2011	Heyl & Patterson, Inc. Unloader	2	✓									

Client & Location	Year	Crane Supplier & Crane Type (Twin-Lift STS typical)	Number of Cranes	Services Provided									
				Health Assessment				Damage Assessment					
				Condition Survey	Inspection Program	Life Assessment	Repair Program	Earthquake	Voyage Collision	Hurricane	Vibration	Fatigue or Operations	Corrosion
Freeport Container Port Grand Bahama	2011	Hyundai Monogirder	9	✓	✓		✓			✓			
Freeport Container Port Grand Bahama	2010	OMG Monogirder	4	✓			✓			✓			
Panama Ports Corp. Panama	2010	Samsung & Hitachi	2	✓			✓						✓
Confidential	2010	Paceco Torque Unloader	1	✓	✓		✓						
PSA Corporation Singapore	2009	MGM, MHI, and MES A-frame	6	✓	✓	✓	✓						
Jakarta Int'l. Container Terminal Jakarta, Indonesia	2009	Hitachi	1	✓								✓	
Jakarta Int'l. Container Terminal Jakarta, Indonesia	2009	Gunanusa Paceco	2	✓									
Confidential	2008	MES Grab Unloader & Babcock-Moxey Stacker Reclaimer	2	✓	✓		✓						
DP World Southampton, UK	2008	Morris A-frame	7	✓	✓								
Yantian Int'l. Container Terminals West Port Shenzhen, China	2008	SPMP A-frame	3	✓	✓	✓	✓						
McKay Int'l. Engineers Benicia, California	2007	ZPMC A-frame	14				✓					✓	

				Services Provided									
				Health Assessment				Damage Assessment					
Client & Location	**Year**	**Crane Supplier & Crane Type (Twin-Lift STS typical)**	Number of Cranes	Condition Survey	Inspection Program	Life Assessment	Repair Program	Earthquake	Voyage Collision	Hurricane	Vibration	Fatigue or Operations	Corrosion
COSCO-HIT Hong Kong	2007	IHI Articulated boom, A-frame	4	✓	✓		✓						✓
Price Companies Inc. Oklahoma	2007	Log Handling Crane	1	✓	✓		✓						
Maryland Port Administration Baltimore, Maryland	2006	Price Revolver	1	✓			✓				✓	✓	
Marine Technical Services, Inc. Los Angeles, California	2006	AmClyde Revolver	1	✓	✓		✓					✓	
Manzanillo Int'l. Terminal Panama	2006	Hyundai A-frame	1				✓					✓	
Manzanillo Int'l. Terminal Panama	2006	ZPMC A-frame	6				✓				✓	✓	
APM Terminals New Jersey	2006	ZPMC Underhung trolley	6	✓	✓		✓					✓	
Hongkong Int'l. Terminals Ltd. Hong Kong	2006	ZPMC A-frame	1				✓				✓	✓	
USS-Posco Industries Pittsburg, California	2006	Paceco A-frame	2				✓					✓	
Hongkong Int'l. Terminals Ltd. Hong Kong	2006	MHI RMGC	24				✓					✓	
ZPMC, China FDRC, UK	2006	ZPMC A-frame	1						✓				

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SELECTED CRANE MAINTENANCE PROJECTS

Client & Location	Year	Manufacturer & Crane Type	Number of Cranes	Services Provided: Condition Survey	Inspection Program	Life Assessment	Repair Program
Maher Terminals New Jersey	2020	Fantuzzi A-frame	5		✓		
DP World Canada Saint John, NB, Canada	2018	Paceco A-frame	2		✓		
Parsons Brinckerhoff Confidential	2012	Alliance Machine Works Goliath, 1969	1	✓			✓
Rio Tinto Alcan Quebec, Canada	2012	Heyl & Patterson, Inc., Bulk Unloader	2	✓		✓	
DP World Vancouver BC, Canada	2009	Reggiane A-frame	1	✓	✓		
PSA Corporation Singapore	2009	MGM, MHI, and MES A-frame	6	✓	✓	✓	✓
Jakarta Int'l. Container Terminal Jakarta, Indonesia	2009	Hitachi	1	✓			
Jakarta Int'l. Container Terminal Jakarta, Indonesia	2009	Gunanusa Paceco	2	✓			
DP World Southampton Southampton, UK	2008	Morris A-frame	7	✓	✓		
Yantian Int'l. Container Terminals, West Port Shenzhen, China	2008	SPMP A-frame	3	✓	✓	✓	✓
McKay Int'l. Engineers Benicia, California	2007	ZPMC A-frame	14				✓
COSCO-HIT Hong Kong	2007	IHI Articulated Boom, A-frame	4	✓	✓		✓
Price Companies Inc. Oklahoma	2007	Log Handling Crane	1	✓	✓		✓
Maryland Port Adm. Baltimore, Maryland	2006	Price Revolver	1	✓			✓

Client & Location	Year	Manufacturer & Crane Type	Number of Cranes	Services Provided: Condition Survey	Inspection Program	Life Assessment	Repair Program
Marine Technical Services, Inc. Los Angeles, California	2006	AmClyde Revolver	1	✓	✓		✓
Manzanillo Int'l. Terminal Panama	2006	Hyundai A-frame	1				✓
Manzanillo Int'l. Terminal Panama	2006	ZPMC A-frame	6				✓
APM Terminals New Jersey	2006	ZPMC Underhung Trolley	6	✓	✓		✓
Hongkong Int'l. Terminals Ltd. Hong Kong	2006	ZPMC A-frame	1				✓
USS-Posco Industries Pittsburg, California	2006	Paceco A-frame	2				✓
Hongkong Int'l. Terminals Ltd. Hong Kong	2006	MHI RMG	24				✓
Yantian Int'l. Container Terminals Ltd., China	2005	HHI A-frame	2	✓	✓	✓	
Yantian Int'l. Container Terminals Ltd., China	2005	MES A-frame	7	✓	✓	✓	
Dongbu Port Container Terminal Busan, Korea	2004	Hanjin A-frame	7	✓			
Yantian Int'l. Container Terminals Ltd., China	2004	ZPMC, MHI A-frame	3, 3	✓	✓	✓	
Yantian Int'l. Container Terminals Ltd., China	2003	Konecranes A-frame	3	✓	✓	✓	✓
FDRC Felixstowe, UK	2002	ZPMC A-frame	2	✓			✓

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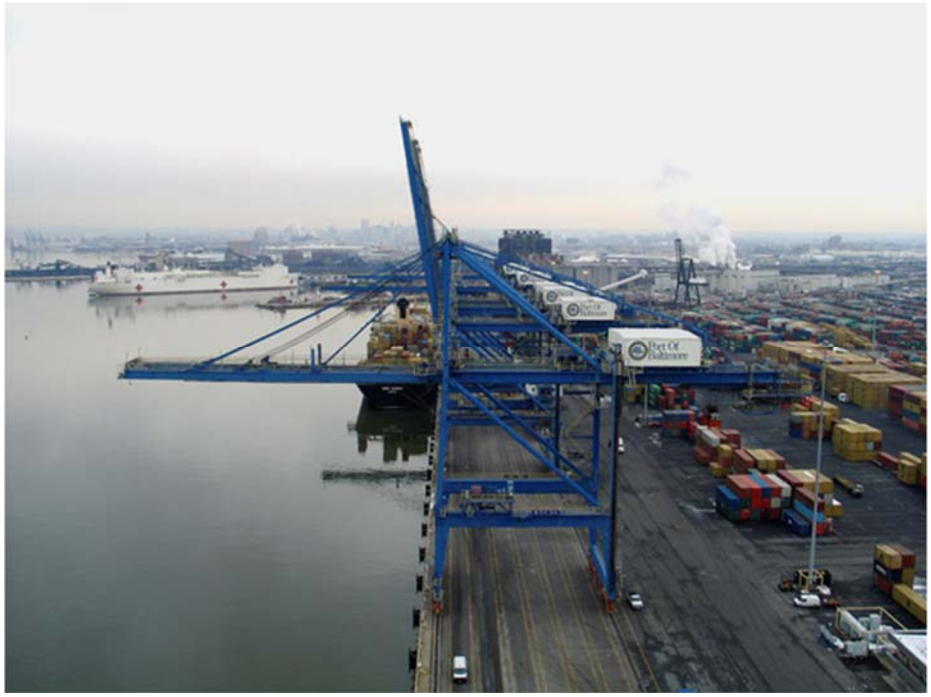

Crane Structural Maintenance
Seagirt Marine Terminal, Maryland

MPA operates seven similar Sumitomo dockside cranes at Seagirt Marine Terminal. The cranes had not previously been inspected using NDT techniques such as MT or UT. Liftech performed a structural condition survey and developed structural inspection manuals.

Reference:
Maryland Port Administration
Baltimore, Maryland, USA

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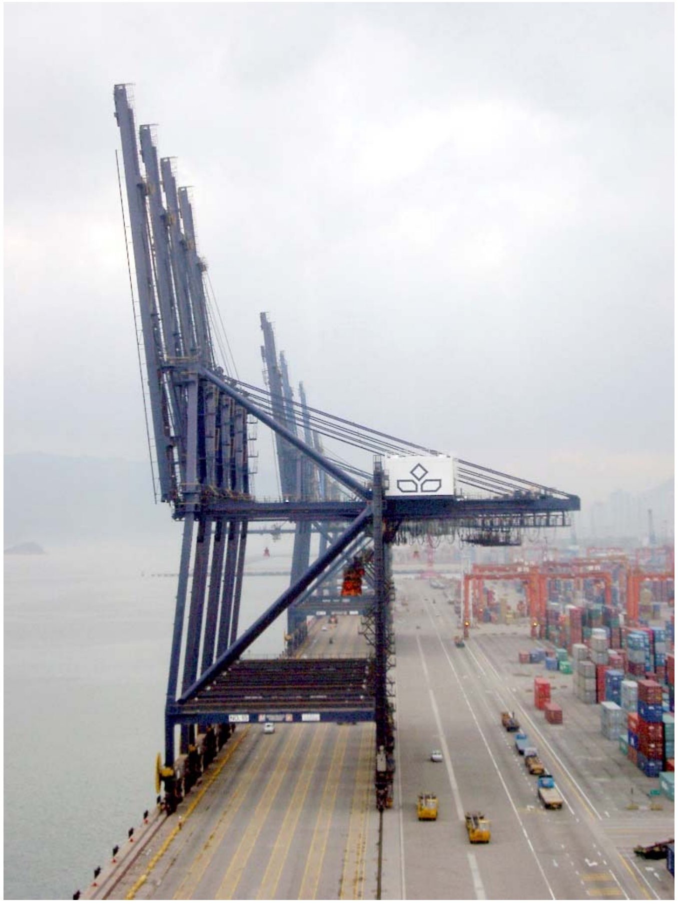

Crane Structural Maintenance
Yantian International Container Terminals Limited

YICT operates three Mitsubishi, three ZPMC, seven Mitsui, and two Hyundai cranes at their Yantian terminal facility. The cranes had not previously been inspected using NDT techniques such as MT or UT.

Liftech performed a useful life assessment, developed a comprehensive structural maintenance program, and prepared NDT inspection manuals. After the inspections were complete, Liftech also developed procedures to repair the detected defects.

Reference:
Yantian International Container Terminals Limited
Shenzhen, China

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Bauxite Unloader
Structural Design Review

Liftech provided structural design review of a bauxite unloader in South America.

We reviewed the workmanship of the primary structure, performed finite element analyses, reviewed design drawings, and provided wheel load and stability calculations.

Liftech provided a report of the significant findings of our review and recommendations for improvements. We also provided a comprehensive structural maintenance program based on cumulative fatigue damage analysis.

Client:
McKay International Engineers
Benicia, California, USA

Owner:
Confidential

COMPANY OVERVIEW

Liftech Consultants Inc. is a consulting engineering firm, founded in 1964, with special expertise in the design and procurement of dockside container handling cranes and other complex structures. Our experience includes structural design for wharves and wharf structures, heavy lift structures, buildings, container yard structures, and container handling equipment. Our national and international clients include owners, engineers, operators, manufacturers, and riggers.

Design Philosophy

We design functional, environmentally sound structures for the most economical investment. We believe in converting natural resources and labor into usable facilities that are a blend of aesthetic, structural, and functional considerations. We work well with owners, engineers, contractors, and architects.

Crane Design

We design cranes for most of the world's container crane manufacturers.

> For Paceco, we developed the original standard A-frame, modified A-frame, low profile quay cranes, and RTG and RMG frame structures that have become the industry standard.
>
> For Mitsubishi, we provided structural design for the first machinery-on-trolley cranes to meet the strict stiffness criteria of the Port of Singapore Authority.
>
> For Paceco, Italimpianti, and Samsung, we designed the then largest low profile cranes and provided designs of articulated boom cranes worldwide.
>
> Most recently, we helped design the largest quay crane for ZPMC with a 100-ton capacity and reviewed many of the manufactured DHT40 (dual-hoist- tandem-40) cranes.

Crane Procurement

We provide crane procurement assistance to numerous port authorities, shipping lines, and terminal operators. Our services range from preparing specifications to complete assistance, including bid evaluation, design review, quality assurance audits, and fabrication inspection. We have written specifications to assist in the procurement of hundreds of container cranes, most of which are super post-Panamax.

Crane Modification & Repair

We design modifications to increase the lift height, extend the outreach, increase the capacity, and change the rail gage for numerous cranes. For use in raising cranes, we designed jacking frames that dramatically decrease the out-of-service time for the crane. We are often called upon for consultations on damaged cranes. Our repair services include condition review, repair assessment, design of temporary securing, design of repairs, and oversight of the repair work. The repairs may involve replacing members, strengthening local areas, or heat straightening.

Crane Assessment

We help clients with crane equipment assessment and recommendations for purchase, modification, or repair. Our services include useful life assessment, reliability studies, condition surveys, and inspection programs. We are occasionally retained as an expert witness to assess crane accidents, evaluate repair estimates, and help resolve disputes.

Crane Transfer Systems

We designed many systems for transferring container cranes between non-linear berths including above ground shuttles, below ground shuttles, turntables, and curved rails with and without switches. We developed a computer program that calculates the near optimal curved rail geometry that typically avoids the need for a side shift mechanism between the crane and its gantry system.

Heavy Lift Design and Review

Liftech has provided structural design and review of heavy lift and crane structures for nuclear power plants, offshore platforms, and other special structures since the 1970s. Our expertise also includes structural design and review of floating cranes of capacity up to 12,000 t and a 1,700-t floating crane that was used to erect the major components of the San Francisco-Oakland Bay Bridge self-anchored suspension span. The barge mounted 1,700-t floating crane was built by ZPMC in China and is suitable for handling large bridge components.

Building Design

Our building design experience ranges from one-story and two-story tilt-up concrete buildings with steel or wood framing to multi-story braced frame steel buildings. The buildings are generally for port, office, commercial, and industrial uses. In addition to traditional building structures, we also design miscellaneous structures in port terminals including canopies, light poles, guard booths, and truck wash facilities. During the design process, we review our designs with owners and contractors to ensure the most cost-effective design.

Wharf and Pier Structures

We provide design and analysis services for wharf and pier structures. Our experience includes the design of wharf and pier structures for large earthquake loads, including cast-in-place and precast concrete systems, as well as steel systems. Projects include design of the following:

A MOTEMS-compliant wharf. The design permitted continued operations during construction by fabricating most of the structures off-site and installing prefabricated components between vessel calls.

A 426-foot wharf in Redwood City designed to state-of-the-art seismic criteria and to support mobile crane operations.

A 550-foot wharf at the Port of West Sacramento that supports a cement unloader.

Over 5,000 feet of wharves at the Port of Oakland that support container cranes.

We evaluated all of the wharves at the Ports of Oakland and Virginia to determine the crane girder capacities to aid the ports in their equipment decisions. We have performed evaluation studies and have justified increased crane girder capacities for over a dozen girder systems. We have performed wharf evaluations for heavy temporary loadings, e.g., moving container cranes over the wharf.

Float Design and Analysis

We provide design and analysis services for float structures, including cranes mounted on barges and ships and floats for ferry terminals and other facilities. Projects include design of the following:

Steel barge support structure for the Left Coast Lifter, a 1,700-t capacity shear leg derrick.

Post-tensioned concrete float system including float, gangway, and piling for the WETA South San Francisco Ferry Terminal.

Two steel floats including piling for the WETA Pier 9 layover berths in San Francisco.

Steel float for the WETA Clay Street Ferry Terminal in Oakland.

Pile-supported pier, piling, and concrete float system fendering and mooring systems for berthing up to 12 ferry vessels for the WETA Central Bay Operations & Maintenance Facility in Alameda.

Two new steel floats with associated super structures and mooring berthing systems, three new gangways, and existing float refurbishment for the WETA Downtown San Francisco Ferry Terminal.

Steel float, gangway, prefabricated pier, and piling for a floating fire station in San Francisco.

Steel floats for ferry terminals at Seaplane Lagoon in Alameda and Treasure Island.

Equipment Transportation

We provide engineering for the transportation of cranes, oil processing modules, offshore oil structure components, and miscellaneous equipment on barges and ships. Our services include checking the structures and the vessels for voyage forces, designing any required reinforcing for the structure and/or vessel, and designing the attachments to the vessel.

Seismic Design

Our experience with seismic design includes evaluation and design of buildings, container cranes, unloaders, and wharf structures. After the Loma Prieta earthquake, we provided structural evaluation of several buildings. After the Guam and Kobe earthquakes, we evaluated crane and wharf structures and helped owners determine the future of their structures. We provided the design reconstruction of a portion of the wharf at Guam. For new cranes, buildings, and other structures, we provide innovative and economical earthquake-sound designs using the latest technology. We have performed seismic studies using finite element time history analysis to evaluate the performance of several container crane and unloader structures.

Crane Analysis Software

We developed a proprietary program for the design and analysis of quay cranes and other container handling equipment. The program is capable of designing or analyzing cranes for the various international standards. We have licensed the software to select crane manufacturers.

Computers

We take pride in providing all employees with the latest computer technology. We use structural software that was written by Liftech, as well as third party software such as *SAP 2000, RAM, AutoCAD, Autodesk Inventor, Bluebeam Revu, Microsoft Office Suite,* and *Adobe Acrobat.*

More Information

For more information, please visit the Liftech website: www.Liftech.net

COMPANY PRINCIPALS

Erik Soderberg
President, Structural Engineer

Mr. Soderberg is a skilled designer and project manager. He is experienced in the design, review, repair, and modification of a variety of structural and crane related systems including wharves, container cranes, and bulk loader structures. Other structures include crane lift and transfer systems and concrete and steel floats. He oversees the technical and contractual aspects of Liftech's projects in addition to his design work.

Jonathan Hsieh
Vice President, Structural Engineer

Mr. Hsieh is experienced in design, review, analysis, and modification of container cranes, bulk handling cranes, and special structures. His expertise includes crane procurement, fatigue failure investigation and repair, and computer modeling and analysis. He has also worked on structural maintenance programs, seismic design of container cranes, crane instrumentation, and voyage bracing.

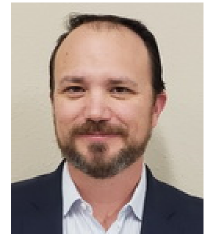
Arun Bhimani
Founding Principal, Past President, Structural Engineer

Mr. Bhimani is an expert in all phases of container crane and wharf design. He has developed innovative solutions to container crane design problems, including a technique for combining analysis with heat straightening for repairing damaged container crane booms, the first seafastening design for transporting fully erected container cranes on barges, and a structural maintenance program used to periodically inspect cranes.

Catherine Morris
Vice President, Structural Engineer

Ms. Morris has a wide range of experience in the design of container cranes, buildings, and miscellaneous special structures. She has worked on all facets of container crane design including designing new cranes, reviewing crane designs, designing modifications, and voyage bracing. She has also reviewed and designed reinforcing for barge structures for transport of various equipment, designed chassis storage racks, and analyzed and designed equipment to lift and replace steam generators in nuclear power plants.

Nicholas Grebe
Principal, Mechanical Engineer



Mr. Grebe has extensive experience performing conceptual and detailed designs of mechanisms and systems, analyzing dynamic mechanical systems, and developing designs and detailed drawings suitable for manufacture. He is responsible for developing purchase specifications and reviewing contractors' mechanical, hydraulic, and electrical designs for feasibility and contract compliance. He is experienced in reviewing heavy machinery and container crane controls including logic, interlocks, system architecture, and automation features. He provides project management, condition assessment, commissioning, troubleshooting, and acceptance testing of material handling equipment including container cranes and bulk loaders.

Sugiarto Loni
Principal, Structural Engineer

Mr. Loni has extensive management experience and design expertise with marine terminal structures including crane-wharf interface, container and intermodal yard structures, building facilities, and marine structures. He is responsible for contract negotiations, technical oversight, and quality assurance of project deliverables. His work includes managing a variety of engineering projects ranging from small projects with short duration to large projects with multi-discipline coordination. As project engineer, he performs civil and structural design of marine terminal facilities, seismic retrofit design of existing building structures, and civil and structural design of wharves and marine structures.

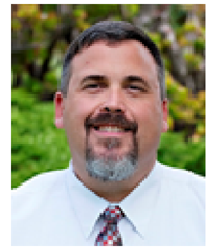
Kenton Lee
Principal, Structural Engineer

Mr. Lee is experienced in design, analysis, and project management of container cranes, floating cranes, rigging, and special structures. He specializes in container and floating crane procurement projects and crane modification projects. He is also involved in preparing structural maintenance programs. Some of the technical aspects of his work that are of special interest to him are steel connection design, wind effects on structures, wind tunnel testing, and structural fatigue of steel structures.

Patrick McCarthy
Principal, Professional Engineer

Mr. McCarthy is experienced in ship-to-shore and port yard container crane procurement, modification, reliability, and repairs. His work includes project management, condition assessment, and developing structural maintenance programs and repair procedures. He is Liftech's manager for developing crane technical specifications and helps clients with various aspects of the crane procurement process, including pre-bid assistance, post-award design and fabrication review, and post-delivery structural assessment. He also has expertise in wind provisions, has been involved in wind tunnel and other wind studies, and is an associate member of the Wind Load Subcommittee of ASCE 7.

Derrick Lind
Principal, Structural Engineer



Mr. Lind is experienced with project management, design, review, analysis, and modification of many types of structures, including container cranes, unique industrial equipment, buildings, wharves, and bridges. He specializes in all facets of crane modification, including crane raises, boom extensions, capacity upgrades, and wheel load feasibility studies. His work has included crane procurement, structural analysis and design, checking shop drawings, developing construction documents, and managing design teams and project budgets and schedules.

Simo Hoite
Principal, Professional Engineer

Mr. Hoite is a registered professional engineer with extensive experience in container crane design, modifications, specifications, and procurement, as well as container and rail terminal operations. His experience includes development of innovative RTG and STS crane designs for container terminals. He is also experienced in the heavy rigging industry and has managed substantial design projects including wharf design.

Anna Dix
Principal, Structural Engineer

Ms. Dix is a registered structural engineer in California with experience in the design and analysis of various steel and concrete structures. Her focus is on ship-to-shore cranes and other structures that reside next to, in, or on top of the water, such as heavy lift and container handling equipment, wharves, and floating cranes. She likes earthquake and fatigue engineering topics and working with clients.

Leah Olson
Principal, Professional Engineer

Ms. Olson has managed multiple wharf and float projects, and has participated in the design, analysis, and modification of wharf and float structures, container cranes, steel barges, and other rigging structures. She has evaluated the behavior of various concrete and steel structures using finite element analysis (FEA) computer software. Her work includes project management, structural analysis and design, and site inspection and reporting.

Di Liu
Principal, Professional Engineer

Mr. Liu is an experienced designer and project manager. His work includes structural analysis, design review, modification review, and feasibility studies of container cranes, wharves, and other structures.